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APPLIED MATERIALS/BSTZ
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte KEVIN MUKAI
and SHANKAR CHANDRAN

Appeal 2009-002624
Application 09/910,583
Technology Center 1700

Decided:¹ June 01, 2009

Before BRADLEY R. GARRIS, CHUNG K. PAK, and
CHARLES F. WARREN, *Administrative Patent Judges*.

PAK, *Administrative Patent Judge*.

DECISION ON APPEAL

¹ The two-month time period for filing an appeal or commencing a civil action, as recited in 37 C.F.R. § 1.304, begins to run from the Decided Date shown on this page of the decision. The time period does not run from the Mail Date (paper delivery) or Notification Date (electronic delivery).

This is a decision on an appeal under 35 U.S.C. § 134 from the Examiner's final rejection of claims 14 through 17. Claims 18, 19 and 23, the other pending claims in the above-identified application, were allowed by the Examiner. We have jurisdiction pursuant to 35 U.S.C. § 6.

We AFFIRM.

STATEMENT OF THE CASE

The subject matter on appeal is said to be directed to a method “for controlling dopant concentration during borophosphosilicate glass (BPSG) film deposition on a semiconductor wafer to reduce consumption of nitride layer on the semiconductor wafer.” (Spec. 1, Para. 0001). Typically, borophosphosilicate glass (BPSG) film deposited on a silicon nitride film on a semiconductor substrate, upon being subjected to conventional wet annealing for the planarizing purpose, produces phosphoric acid due to the reaction between phosphorous in the BPSG layer and water vapor. (Spec. 3, Para. 0005). Phosphoric acid, a well known etch agent for a silicon nitride, is expected to consume the silicon nitride layer. *Id.* To avoid the problem of phosphoric acid stripping the silicon nitride layer, the only embodiment described in the Summary of the Invention section of the Specification states that:

In one embodiment of the invention, the method starts by placing a substrate having a nitride layer in a reaction chamber and providing a silicon source, an oxygen source and a boron source into the reaction chamber while delaying providing a phosphorous source into the reaction chamber to form a borosilicate glass [BSG] layer over the nitride layer. The method continues by providing the silicon, oxygen, boron and phosphorous sources into the reaction chamber to form a

borophosphosilicate [BPSG] film over the borosilicate glass layer.

(Spec. 4, Para. 0007). According to page 7, paragraph 0018, of the Specification:

The boron-rich silicon film [i.e., the BSG layer] deposited between a BPSG film and the nitride barrier layer acts as a diffusion layer to slow down reactions during steam anneal between nitride and phosphorous, thus reducing the nitride consumption during substrate processing.

The Specification, at pages 12 and 13, paragraph 0033, describes the need for stabilizing silicon, boron and phosphorus sources prior to introducing and mixing them in the deposition chamber as shown below:

Although the following describes operation of the gas delivery system with respect to one vaporizer, it is understood that other vaporizers of the processing system may also operate similarly. The input valve 262 and output valve 272 connected to the vaporizer 202 operate synchronously to switch input and output of the vaporizer 202 between a process mode and a divert mode. To begin a vaporization process, the LFM is opened to allow flow from the liquid precursor source 222 into the injection valve 212 of the vaporizer 202, the input valve 212 of the vaporizer 202 is switched to receive carrier gas from the second input 282 which is connected to the divert carrier gas source 210. At the same time, the output valve 272 of the vaporizer 202 is switched to the second output 292, the vaporizer 202 is defined as operating in a divert mode. Because the LFM has an inherent delay (i.e., rise time) before liquid flow through the LFM has stabilized, and [sic.] the vaporized gas output from the vaporizer is diverted to the foreline of the exhaust system during this initial vaporization period. Thus, the process gas is not introduced into the chamber during this initial period because the process gas has a concentration

gradient caused by the rise time of the LFM, and the deposited film formed subsequently on a substrate in the chamber does not exhibit concentration profiles reflecting the rise of time of the LFM.

Implicit in this disclosure is that the oxygen gas source, which is not subject to vaporization or mixing (forming a mixture with a carrier gas), is already stable even before it is ejected into and mixed in a deposition chamber.

Details of the appealed subject matter are recited in representative claim 14 reproduced below²:

14. A method of forming an insulating film on a substrate to reduce nitride consumption during manufacture, the method comprising:

placing a substrate having a nitride layer thereon in a reaction chamber;

providing a silicon source, an oxygen source, a boron source and a phosphorous source for chemical vapor depositing a doped silicate glass layer over the nitride layer; and

prior to mixing any of the flows of the silicon, oxygen, boron or phosphorous sources, stabilizing individually the flows of the silicon, oxygen, boron and phosphorous sources;

injecting the silicon source, the oxygen source and the boron source into the chamber for a predetermined period of time to form a borosilicate glass layer over the nitride layer on the substrate; and

injecting the phosphorous source into the chamber while continuing injecting the silicon, oxygen and boron sources into the chamber to deposit a borophosphosilicate glass layer over the borosilicate glass layer.

² We limit our findings and conclusions to claim 14 only consistent with 37 C.F.R. § 41.37(c)(1)(vii) (2005). Appellants have not separately argued the limitations of claims 15-17 on appeal. (App. Br. 6-10 and Reply Br. 1-4).

As evidence of unpatentability of the appealed subject matter, the Examiner proffered the following prior art references:

Li-Qun	EP 0 843 348 A2	May 20, 1998
Germann	EP 1 139 403 A1	Apr. 10, 2001
Yang (as translated)	KR 2001-0055915	Jul. 4, 2001

The Examiner rejected claims 14 through 17 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Yang, Li-Qun, and Germann.

Appellants traverse, arguing that the Examiner erred in rejecting the claims on appeal under 35 U.S.C. § 103 as unpatentable over the combined disclosures of Yang, Li-Qun, and Germann. Specifically, Appellants contend that one of ordinary skill in the art would not have been led to stabilize “individually the flows of the silicon, oxygen, boron and phosphorous sources” prior to mixing any flows of these sources and depositing a borosilicate glass (BSG) layer on a nitride layer and a borophosphosilicate glass (BPSG) layer over the borosilicate glass layer as required by claim 14.

ISSUE

The dispositive question is: Have Appellants identified any reversible error in the Examiner’s determination that one of ordinary skill in the art, armed with the knowledge of the disclosures of Yang, Li-Qun, and Germann, would have been led to stabilize “individually the flows of the silicon, oxygen, boron and phosphorous sources” prior to mixing any flows of these sources to deposit a borosilicate glass (BSG) layer on a nitride layer

and a borophosphosilicate glass (BPSG) layer over the BSG layer as required by claim 14 within the meaning of 35 U.S.C. § 103?

CONCLUSION

On this record, we answer the above question in the negative.

RELEVANT FACTUAL FINDINGS (FF)

1. Yang, like Appellants, teaches applying a BSG film over a silicon nitride film on a substrate and then a BPSG film over the BSG film to prevent or reduce phosphoric acid from the BPSG film during wet annealing from etching and stripping the silicon nitride film (pp. 5 and 6).
2. Yang, like Appellants, teaches “utilizing the difference in the time in which . . . source gases [of boron (i.e., TEB) and phosphorus (i.e., TEPO)] are stabilized” to form the BSG film first over the silicon nitride film and then form BPSG film later over the BSG film due to the delay of the flow of a stabilized phosphorus source gas (i.e., TEPO) (p. 5).
3. Yang, like Appellants, teaches stabilizing “at least two or more different source gases” to prevent the formation of voids (pp. 4-6) and specifically identifies TEB (a boron source gas), TEPO (a phosphorus source gas), and TEOS (a silicon source gas) (p.6).
4. Yang teaches that:

As shown in Figure 2, it can be understood that the TEB has already been stabilized and flowed at about 200 sccm and TEPO is stabilized after about 9 sec and flowed at about 40 sccm. Here, TEOS is stabilized from the initial stage and flowed at about 600 sccm.

(*Id.*).

5. Yang, like Appellants, teaches heating the resulting semiconductor product at a temperature of 800 to 900 °C under O₂ and H₂ flow (wet flow) consistent with the claimed annealing step (pp. 5 and 6).
6. Although Yang does not specifically mention using an oxygen source gas in forming its BSG and BPSG films, it can be inferred from Yang and Li-Qun that such oxygen source gas in stable form³ is used since Yang teaches stabilizing two or more source gases utilized to form its BSG and BPSG films as indicated *supra* and, since Li-Qun at pages 30 and 31 teaches an oxygen source gas as one of the source gases utilized in forming BSG and BPSG films.
7. Li-Qun teaches that an oxygen source gas is used either together with TEB and TEOS to form a BSG film, or together with TEB, TEOS, and TEPO, to form a BPSG film (pp. 30-31).
8. Germann teaches (col. 1, para. 0006) that:

When a doped silicon oxide layer is deposited upon a substrate surface the variation in dopant concentration is very high for the first deposited nanometers. This is due to the non-constant gas mixture ratio for the different precursor gases, which stabilize during the first moments, when the first nanometers of the BPSG are deposited.

³ Li-Qun, like Appellants, teaches at pages 30 and 31 that the silicon, boron and phosphorous gas sources are formed by evaporating liquids, such as TEB as the source of boron, TEOS as the source of silicon, and TEPO as the source of phosphorus, and combining them individually with a carrier gas, such as helium. In other words, a mixture of a carrier gas and either TEB, TEOS, or TEPO is formed as an individual gas source useful for forming BSG and BPSG films, thus requiring time to stabilize the concentration of TEB, TEOS or TEPO in the carrier gas as taught by page 6 of Yang and/or column 1 of Germann. However, an oxygen gas source is not a mixture and is not required any time to stabilize an oxygen concentration.

9. To avoid such a problem, Germann teaches “a method for stabilizing the gas flow, gas mixing and dopant concentration by bypassing mixed gases (11, 12) outside a reactor (8)” (abstract and cols. 1 and 2, paras. 0008-0010).

PRINCIPLES OF LAW

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) secondary considerations, if any. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966).

As stated in *KSR Int’l Co., v. Teleflex, Inc.*, 550 U.S. 398, 417-418 (2007):

“[A]nalysis [of whether the subject matter of a claim would have been *prima facie* obvious] need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.”

See also DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co., 464 F.3d 1356, 1361 (Fed. Cir. 2006) (“The motivation need not be found in the references sought to be combined, but may be found in any number of sources, including common knowledge, the prior art as a whole, or the nature of the problem itself.”); *In re Preda*, 401 F.2d 825, 826-827 (CCPA 1968) (“[I]n considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but

also the inferences which one skilled in the art would reasonably be expected to draw therefrom.”).

“[W]here the prior art gives reason or motivation to make the claimed [invention] . . . the burden (and opportunity) then falls on an applicant to rebut that *prima facie* case. Such rebuttal or argument can consist of . . . any other argument or presentation of evidence that is pertinent.” *In re Dillon*, 919 F.2d 688, 692-93 (Fed. Cir. 1990)(*en banc*). Appellants’ mere arguments in the Brief or conclusory statements in the Specification not supported by factual evidence are not sufficient. *See, e.g., In re De Blauwe*, 736 F.2d 699, 705 (Fed. Cir. 1984); *In re Lindner*, 457 F.2d 506, 508 (CCPA 1972).

ANALYSIS,

Appellants have not identified any reversible error in the Examiner’s determination that one of ordinary skill in the art would have been led to stabilize “individually the flows of the silicon, oxygen, boron and phosphorous sources” prior to mixing any flows of these sources to deposit a borosilicate glass (BSG) layer on a nitride layer and a borophosphosilicate glass (BPSG) layer over the BSG layer as required by claim 14 within the meaning of 35 U.S.C. § 103.

As indicated *supra*, Yang, like Appellants, teaches “utilizing the difference in the time in which . . . source gases [of boron (i.e., TEB) and phosphorus (i.e., TEPO)] are stabilized” to first form a BSG film over a silicon nitride film and then form a BPSG film over the BSG film due to the delay of the flow of a stabilized phosphorus source gas (i.e., TEPO). Yang

also teaches stabilizing “at least two or more different source gases” to prevent the formation of voids and specifically mentions stabilizing TEB (a boron source gas), TEPO (a phosphorus source gas), and TEOS (a silicon source gas).

Yang does not specifically mention using an oxygen source gas in forming BSG and BPSG films. However, it can be inferred from the teachings of Yang and Li-Qun that such oxygen source gas in stable form is necessarily employed in Yang’s process. While Li-Qun at pages 30 and 31 teaches that such oxygen source gas must be used, together with TEB, TEOS, and/or TEPO to form BSG and BPSG films, Yang teaches or suggests that all the source gases utilized to form its BSG and BPSG films can be individually stabilized as indicated *supra*.

In any event, Germann teaches (col. 1, para. 0006) that:

When a doped silicon oxide layer is deposited upon a substrate surface the variation in dopant concentration is very high for the first deposited nanometers. This is due to the non-constant gas mixture ratio for the different precursor gases, which stabilize during the first moments, when the first nanometers of the BPSG are deposited.

To avoid such a problem, Germann teaches in its abstract “a method for stabilizing the gas flow, gas mixing and dopant concentration by bypassing mixed gases (11, 12) outside a reactor (8)”. Implicit in this teaching in Germann is that the individual gas flow must be stabilized before forming a stable gas mixture. On this record, Appellants have not demonstrated that Germann does not stabilize the individual source gases before forming a stable gas mixture.

It follows that one of ordinary skill in the art would have been led to stabilize the individual source gas flow either to form a stable gas mixture for deposition or before mixing and depositing the resulting gas mixture to form BSG and BPSG layers as suggested by Yang, Li-Qun and Germann.

Accordingly, based on the totality of the record relied upon by the Examiner and Appellants, including due consideration of Appellants' arguments in the Appeal Brief and the Reply Brief, we concur with the Examiner that the preponderance of evidence weighs most heavily in favor of obviousness of the subject matter recited in claims 14 through 17 within the meaning of 35 U.S.C. § 103 (a).

ORDER

In view of the foregoing, the decision of the Examiner is affirmed.

TIME PERIOD

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

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APPLIED MATERIALS/BSTZ
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